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A STUDY OF WATER USAGE IN THE NEWLY CONSTRUCTED GREEN BUILDING IN THE ANDHRA UNIVERSITY CAMPUS

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ABSTRACT

Water is truly the elixir of life. The Earth's surface is filled with water by 71.7% but only 3% of this water can be used as potable water. In the Indian cities, the demand for water for domestic use is responsible for a big part of the total consumption, besides industrial use. Buildings are major users of our potable water supply it consumes 20% of the available water. The goal of the Water Efficiency is to encourage smarter use of water, inside and out. The objective of this paper is to highlight the rising need for water conservation and its importance as a part of building design and construction. The study has examined how the International students Hostel in Andhra University is reducing water usage and benefits through its water efficiency measures. To that end, it is hoped that the results of the study would benefit the policy and planning authorities in Andhra University in optimizing the existing water resources for campus development.

KEY WORDS: Water scarcity, Green Building, Hostel, Benefit, Efficiency plumbing fixtures.

1. INTRODUCTION:

The Earth's surface is filled with water by 71.7percent but the only 3 percent of this water [CI.Cheng, 2003& Oindrila Das, Priyanka Bera , Sanjib Moulick, 2015] can be used as potable water. In the Indian cities, the demand for water for domestic use is responsible for a big part of the total consumption, besides industrial use. Buildings are major users of our potable water supply; it consumes 20% of the world's available water. The goal of the Water Efficiency is to encourage smarter use of water, inside and out [Shaid akthar].

The Critical factors in green design, construction, and product selection, according to McGraw-Hill Construction's latest Smart Market Report, are water efficiency and conservation over the next five years. According to reports released, of the all other aspects of green building, water efficiency is rapidly becoming a higher priority over energy efficiency and waste [*Water's Role in Green Building*, 2009]. According to the United Nations Environmental Program, on the ongoing basis buildings are responsible for 30-40 % of energy use and 15-20 % of water use worldwide [Sumateja Reddy.V, 2016& Levine, A.D., and T. Asano, 2004], a resource that becomes scarcer each year.

Per capita water availability as per the National Commission of Integrated Water Resources Development (NCIWRD) projection, the urban water demand in 2025 and 2050 has been assessed at 200 and 220 lpcd [*GRIHA manual*, 2017]. The requirement of a total daily supply of about 8 gallons per person for a day is essential for good health and cleanliness, according to the World Health Organization (WHO) [UNESCO 2003 & Bahar Zoghi Moghadam , 2009]. Water efficiency strategies in green building practices are becoming paramount to new and existing construction efforts.

The efficient practices and products that will turn the tide on the water crises, such as the gray water treatment and low-flow plumbing fixtures, provide significant opportunities for the architecture and engineering industry to build high-tech, low-water-demand projects and create the conscientious buildings of tomorrow [*Water's Role in Green Building*, 2009].

With annual precipitation averaging around 955 mm, Visakhapatnam is located in the Asian monsoon area and a good supply of rainwater [*Ground water Scenario,2017*]. However, water shortages have recently become a critical problem during the dry season. Given such challenges, Greater Visakhapatnam Municipal Corporation (GVMC) endeavoring to spread the concept of water conservation among their populaces. Consistent with this trend, the Andhra University (AU) proposed the green building concept and prioritizes water conservation as one of its critical categories.

2. SUSTAINABILITY IN CONSTRUCTION

AU constructed the first sustainable building among universities in Andhra Pradesh and adhering to all green building norms. Perhaps this is the first environment-friendly three-storey building to accommodate up to 112 foreign students. The building constructed with an estimated cost of 4.4 cores has spacious corridors and good aeration. The building has load bearing walls made of hollow core (Fig: 1.1) paper mache interlocking block [New indian express 2016]. The hollow core of the interlocking blocks is reinforced with steel bars to form the lintels of the opening.

Fig 1: Curved elevation

Fig 1.1: Interlocking blocks

Fig 1.2: Domed rock roof

Fig 1.3: Recycle material

Fig 1.4: Natural Lighting

Fig 1.5: Filler slab

The building design is also heat-proof and quake-resistant with eight inches thick and load bearing, with the cure walls (Fig:1) add stability to the structure. It was constructed with less energy and easy to handle blocks for the laborers. They used the recycled waste materials (Fig:1.3) with a varied range of bright permanent finishes(Fig:1.6) It also has high thermal insulating properties with the use of waste papers and paper mache (Fig:1.1). This building helps in energy conservation with its spacious corridors and ventilation (Fig:1.4). The building design will also avoid heat entering inside. The building will be eco-friendly and attractive as well. The building would have very minimal maintenance and helps in energy conservation through its water efficiency plumbing fixtures (See Fig:3-3.5).

The following strategies were adopted to reduce the building impact on the natural environment:

A. Sustainable Site Planning

Excavation and construction started after the monsoon season to prevent soil

erosion and soil run off from the site Top soil was preserved and re-used to raise the ground level along the periphery Corridors are planned to cause minimum damage to the site and natural topography

B. Reducing water consumption
Reduction in building water consumption by use of low-flow fixtures

C. Reducing energy consumption
while maintaining occupant comfort: Over 80% of total living area falls under daylit zone, Energy efficient: artificial lighting design is compliant with ECBC. As the local climatic conditions provide good indoor thermal comfort hollow core paper mache block walls to reduce solar heat gain.

D. Use of low energy materials
Use of Kota stone for flooring within all rooms

E. Materials
Use of low-VOC and lead free paints has been used to maintain indoor air quality. The project has demonstrated a reduction in embodied energy by using hollow core paper mache interlocking block. Over 60% of interior finishes are low-energy like kota stone, granite stone, etc

3. GROUND WATER LEVELS AROUND STUDY AREA:
Nearly 85% of the city is underlain by hard rocks and the chief contributors of groundwater in these rocks are the fractured systems. Rainfall is the source of recharge to groundwater and during the last decade, this source has become erratic and sometimes very low. The number of rainy days has also come down[Visakhapatnam Climate Precipitation 2017]. Thus the recharge to groundwater bodies has come down. Apart from this people are resorting to using groundwater more often because, it is economical, easily available and consumes less time to ground a project, in view of the limited surface water resources and their uneven distribution. Thus the strain on groundwater aquifers mostly in upland areas is increasing day by day.

There is a demand for expanding freshwater resources to provide drinking water for increasing population in GVMC is serving at the rate of 116 Liter per capita for day (LPCD) (on an average) as against the norms of 150 LPCD [Urban water supply, GVMC, 2017].

4. THE ROLE OF WATER EFFICIENCY IN GREEN BUILDINGS:
Water efficiency means the reducing usage of water and reducing waste. An important aspect of sustainability is greater water efficiency and it is relatively easy to implement. Additional benefits beyond conserving water include less use off or over watering, pumping costs and offsetting treatment, reduced water payments reduced infrastructure costs from rainwater harvesting and minimized the effect on ecosystems [High efficiency plumbing fixtures, 2012]. Water efficiency means the reducing usage of water and reducing waste. The key for efficiency is reducing not restricting. By using water efficiency we can help preserve water supplies from future generations, save money and protect the environment [Sumateja Reddy.V, 2016]. The all-India pattern of domestic water consumption (Typical) is as below.

Table 1: All India pattern of domestic water consumption
[Veerendra kumar pall, 2013]

Utility	Lpcd
Drinking	5
Cooking	5
Bathing	45
Clothes washing	20
Utensil washing	8
House washing	7
Flushing	45
Total	135

The present study is an attempt to analyses how the green building reduces water usage through its water efficiency measures.

5. OBJECTIVE OF STUDY:
To assess the water consumption in the building by using efficient fixtures, and how it will reduce
water demand as well as energy and water bill.

6. METHODOLOGY
Step1: First estimate the quantity of supply and floor area and occupants data

Step2: Get the water source data for the building and rain water and ground water levels

Step3: Get the water supply rates from sources

Step4: Evaluate how the building is reduce water demand and recommendations if any

7. STUDY AREA:
International Student Hostel, Andhra University, Waltair, Visakhapatnam, a port city on the east coast of India is located between the admission office to its west and the Raja Ratna Towers to its east, bordering on the north with the Cyclone Warning Center and Platinum Jubilee Guest House to the south. The hostel coordinates lies between 17°43'17.8"N latitude, and 83°19'49.0"E longitude (See Fig:2-2.3).

Fig 2: Location of the state

Fig 2.1: Location map of Visakhapatnam district

Fig 2.2: Google earth location

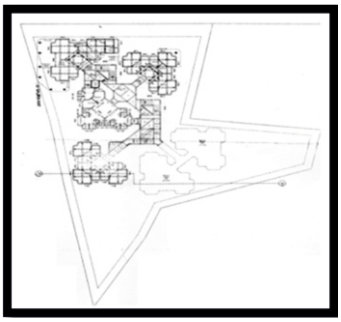

Fig 2.3: Site plan

Table 2: Baseline flow rates/consumption for plumbing fixtures as per IGBC [16]

Fixture Type (pressure at 3 bar)	Maximum Flow Rate/Consumption	Duration	Estimated Daily Uses per FTE
Water closets (Full flush)	6 LPF	1flush	1 for male and 1 for female
Faucets/Taps	6 LPM	15 seconds	4
Water closets (Half-flush)	3 LPF	1 flush	2 for female
Health faucet	6 LPM	15 seconds	1
Urinals	4 LPF	1 flush	2 for male
Shower head/Handheld spray	10 LPM	8 minutes	0.1

Source: Uniform plumbing Code, India (Occupant who spends 8 hours per day in the building).

Table 3: Maximum flow rates of plumbing fixtures, as per different codes
[Mr. Subhash Deshpande]

Plumbing fixtures Flow rate-5.5bars	UPC I (present fixtures)	GPCS I	WEP I 2-3 star rating
WC female	6 lpf	4 lpf dual flush	4 lpf dual flush
WC Male	6 lpf	6 lpf	4 lpf dual flush
Urinals, public	4 lpf	3 lpf	2 lpf
Taps	8 lpf	5.7 lpm	5.7 lpm
Kitchen	8 lpm	8 lpm	5.7 lpm
Shower	10 lpm	7.6 plm	7.5 lpm
Cloths washer			170/60 lit per full load or 550 liters
Dish Washer			45/15 lit per cycle
Taps, public	8 lpm	2 lpm	
Taps, metered		1 lit per cycle	

UPC I - Uniform Plumbing Code India 201

GPCS I - Green Plumbing Code supplement India 2010

WEP I - Water Efficient Products India 2011

8. DISCUSSION AND RESULTS ON WATER EFFICIENCY

A. The Energy, Water and Global Warming Connection

The collection, distribution, and treatment of drinking water and wastewater citywide consume tremendous amounts of energy and release carbon dioxide (Co_2). The energy-water connection is particularly strong in the driest regions where significant amounts of energy are used to import water. Solutions exist to cut both water and energy use. Nationwide, about 4% [*Water facts*, 2009] of power generation is used for water supply and treatment, reducing water consumption saves energy because less water needs to be treated and pumped to end users.

Table 4: How water efficiency save energy

Reduced water requirement reflect the reduced cost and less consumption of energy	
Total consumption-135 l/p/d	Total consumption for effectively reduction 96 l/p/d
No of users: 112x135=15,120 lts	No of users: 112x96lts=10,752 lts
For 1 month =4,53,600 L	For 1 month =3,22,560 L
Energy consumption for pumping 4 hr into 10/- unit for 2 minute, 1hr 60 units, for 1 month=7200 units	Energy consumption for pumping for a 50 min For month = 4824 units
Energy saving=33%	Water saving= 28%

B. Water Efficiency

Water conservation and efficiency fixtures have been implemented as per UPC I-Uniform Plumbing Code India 2011 [Mr. Subhash Deshpande] to lead to substantial decreases in the use of water within the building. Water-efficient appliances and fixtures, behavioral changes, and changes in landscape irrigation methods can reduce consumption by up to 30 percent or more. Investment in such measures can yield payback in one to three years [Sumateja Reddy.V, 2016].

Fig 3: Urinals (4LPM)

Fig. 3.1: low pressure faucet

Fig. 3.2: Faucet with aerator (6lpm)

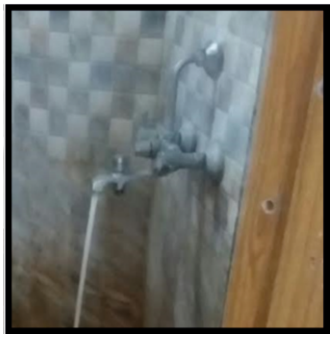

Fig. 3.3: Tap with aerator (5.7lpm)

Fig. 3.4: Duel flush cistern

Fig. 3.5: Shower head with 10lpm

C. Results

The results and discussion of the present study are based on different parameters taken from the table-4, which provide a comprehensive water efficiency data on a hostel building based on different codes. The hostel has achieved the following savings if adopt water efficiency measures as per new codes.

Table 5: Annual Comparison with different codes

	Present fixtures as per UPC I – 2011	Reduction by adopt GPCS I – 2010	Reduction by adopt WEP I – 2011
Water usage-in kilo liters			
Number of building occupants	112	112	112
Water use per occupant per day	0.174	0.135	0.096
Total building water use for day	19.488	15.128	10.750
Total annual building water use	7113.12	55188.00	3924.48
Water cost. Rs			
Water cost per kilo liter-including pumping	60	60	60
Total annual cost	4,26,787	3,31,128	2,35,468
Savings. Rs			
Initial cost of water measures		4,65,000	5,70,000
Annual water conservation reduction		95.659	1,91,319
Payback period		58 months	35 months

*One thousand liters = 1 Kilo liter

Results of the study revealed that the daily average water consumption for the hostel was found to be 174 lt per person per capita per day (as per available data at the office). As table 5 reveals, for a typical 26,851-square-foot hostel building, a 40%&50% reduction respectively in water usage through the installation of efficiency measures can result in annual savings of Rs.95.659/- and Rs.1,91,319/- respectively and payback period of GPCS-1 and WEP-1 is 58 & 35 months on the installed conservation and efficiency measures. In addition to providing a return on investment, the measures result in annual conservation of water. Water efficiency not only can lead to substantial water savings, as shown in the above example, it also can reduce the requirement for expansion of water treatment facilities.

9. RECOMMENDATIONS

The following recommendations are drawn from the analysis made from the study: (1) reduce water + Energy cost. (2) reduce water pressure. (3) install water and energy meters and controls. (4) implement rainwater harvesting, recharge, and storage/use. (5) install limit switches on tanks to eliminate over-flow. (6) grey water use for landscaping and flushing. (7) install fixtures as per WEP 1-2011 code. (8) adopt integrated water cycle management.

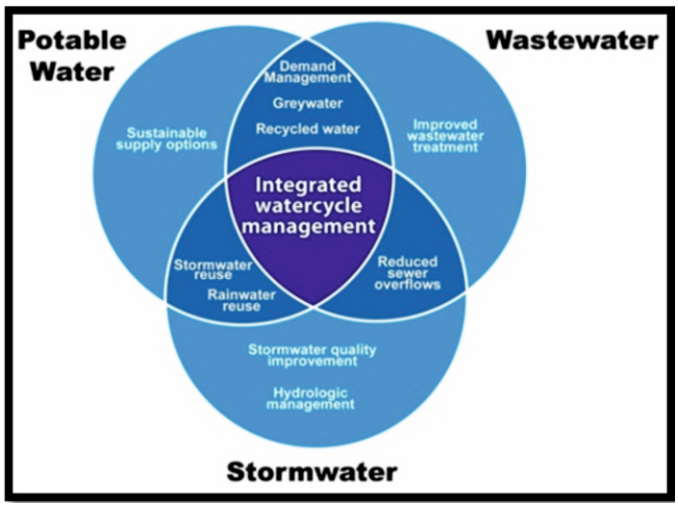

Fig.4 Integrated Water Cycle Management

10. CONCLUSION

It is hoped that the result of the study of this paper is to highlight the rising need for water conservation and its importance as a part of building designing and

construction. The necessity for water conservation has become so much significant that recently IGBC & GRIHA rating systems emphasize the water efficiency measures in the buildings. Water efficiency helps preserve our water supply for future generations. In this case apart from retrofitting existing buildings use high water efficiency plumbing fixtures, to adapt sustainable construction is the only alternative to reducing water demand in the university.

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